

What is claimed is:

1. A surface acoustic wave device comprising:

a surface acoustic wave element including a piezoelectric substrate which includes one principal surface formed with an inter digital transducer electrode, a connector electrode
5 connected to the inter digital transducer electrode and a periphery sealing electrode;

a base substrate formed with an electrode for connection to the element that is connected to the connector electrode,
10 a periphery sealing conductor film joined to the periphery sealing electrode, and an external terminal electrode; and

an outer covering resin layer attached to cover an another principal surface and a side surface of the surface acoustic wave element,

15 wherein the connector electrode and the electrode for connection to the element are joined together through a solder bump component, and the periphery sealing electrode and the periphery sealing conductor film are joined together through a solder sealing component so that a predetermined gap is formed
20 between the base substrate and the surface acoustic wave element,

the solder bump component and the solder sealing component comprise a Sn-Sb based or Sn-Ag based lead-free solder containing 90% or more Sn, and

25 the base substrate has a thermal expansion coefficient

of 9-20 ppm/°C.

2. The surface acoustic wave device according to claim 1,
wherein the base substrate is a glass-ceramic substrate
5 comprising glass-ceramics at interfaces among ceramic powder
particles.

3. The surface acoustic wave device according to claim 1,
wherein the base substrate is a resin substrate reinforced with
10 an inorganic fiber.

4. The surface acoustic wave device according to claim 1,
wherein a relationship of $(S1/L1) > (S2/L2)$ is satisfied where
the area of a vertical cross-section of the solder bump component
15 is $S1$, the area of a vertical cross-section of the solder sealing
component is $S2$, the soldering width of a vertical cross-section
of the connector electrode formed on the surface acoustic wave
element is $L1$, and the soldering width of a vertical
cross-section of the periphery sealing electrode of the surface
20 acoustic wave element is $L2$.

5. The surface acoustic wave device according to claim 1,
wherein the conductor width of the periphery sealing conductor
film of the base substrate is larger than the electrode width
25 of the periphery sealing electrode of the surface acoustic wave

element, and the configuration of an inner periphery of the periphery sealing conductor film and the configuration of an inner periphery of the periphery sealing electrode are generally identical to each other.

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6. The surface acoustic wave device according to claim 5, wherein the periphery sealing conductor film has a substantially uniform conductor width throughout the entire path thereof, and the width of the solder sealing component joined to the periphery
10 sealing conductor film is identical to the conductor width of the periphery sealing conductor film.

7. A surface acoustic wave device comprising:

a surface acoustic wave element including a piezoelectric
15 substrate which includes one principal surface formed with an inter digital transducer electrode, a connector electrode connected to the inter digital transducer electrode and a periphery sealing electrode; and

a base substrate which is formed with an electrode for
20 connection to the element that is connected to the connector electrode, a periphery sealing conductor film joined to the periphery sealing electrode and an external terminal electrode,

wherein the connector electrode and the electrode for
connection to the element are joined together through a solder
25 bump component, and the periphery sealing electrode and the

periphery sealing conductor film are joined together through a solder sealing component so that a predetermined gap is formed between the base substrate and the surface acoustic wave element,

5 a side surface covering resin layer is attached to cover a side surface of the surface acoustic wave element and an outer peripheral surface of the solder sealing component, and the side surface covering resin layer has an elastic modulus which follows a change of a gap between the base substrate and the
10 surface acoustic wave element caused by volume expansion of the solder bump component and the solder sealing component at a melting temperature of the solder bump component and the solder sealing component.

15 8. The surface acoustic wave device according to claim 7, wherein the side surface covering resin layer comprises a resin having thermal reversibility.

9. The surface acoustic wave device according claim 7,
20 wherein the side surface covering resin layer has an elastic modulus of 3.5-6 GPa at 25°C, and an elastic modulus of 0.2-0.4GPa at 230°C.

10. The surface acoustic wave device according to claim 7,
25 wherein a mass per unit volume at temperatures between 180°C

and 250°C of the surface acoustic wave element and the side surface covering resin layer is smaller than a mass per unit volume at temperatures between 180°C and 250°C of the solder bump component and the solder sealing component.

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11. The surface acoustic wave device according to claim 7, wherein a space formed by the surface acoustic wave element, the base substrate and the solder sealing component is hermetically filled with air or an inert gas including nitrogen.

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12. A method for manufacturing a surface acoustic wave device in which a surface acoustic wave element having one principal surface formed with a connector electrode and a periphery sealing electrode is joined to a base substrate formed with an electrode for connection to the element connected to the connector electrode, a periphery sealing conductor film connected to the periphery sealing electrode and an external terminal electrode so that a predetermined gap is formed between the base substrate and the surface acoustic wave element, the method comprising the steps of:

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forming a first solder bump for a solder bump component on either of the electrode for connection to the element of the base substrate and the connector electrode of the surface acoustic wave element;

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forming a second solder bump having a height smaller than

that of the first solder bump on either of the periphery sealing conductor film of the base substrate and the periphery sealing electrode of the surface acoustic wave element;

electrically connecting and temporarily fixing the
5 electrode for connection to the element of the base substrate to the connector electrode of the surface acoustic wave element by means of the first solder bump; and

thereafter fusing the first solder bump and the second solder bump in a predetermined atmosphere so that the periphery
10 sealing conductor film of the base substrate and the periphery sealing electrode of the surface acoustic wave element are hermetically sealed and joined to each other by means of the second solder bump.

15 13. The method for manufacturing a surface acoustic wave device according to claim 12, wherein the first solder bump is formed by printing a solder paste on the electrode for connection to the element or the connector electrode and by a heat treatment and cleaning.

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14. The method for manufacturing a surface acoustic wave device according to claim 12, wherein the second solder bump is formed by printing a solder paste on the periphery sealing conductor film or the periphery sealing electrode and by a heat
25 treatment and cleaning.

15. The method for manufacturing a surface acoustic wave device according to claim 12, wherein the first solder bump and the second solder bump are each formed with printing a solder
5 paste, heat treatment thereof and cleaning process,

the connector electrode and the electrode for connection to the element are temporarily fixed to each other by ultrasonic thermocompression bonding with use of the solder bump for forming the first solder bump, and

10 thereafter both of the solder bumps are fused so as to connect the connector electrode to the electrode for connection to the element and join the periphery sealing electrode to the periphery sealing conductor film.

15 16. The method for manufacturing a surface acoustic wave device according to claim 15, wherein a load is applied to the surface acoustic wave element and the fusing is accomplished by a reflow treatment in the step of fusing the solder bumps so as to connect the connector electrode to the electrode for
20 connection to the element and join the periphery sealing electrode to the periphery sealing conductor film.

17. The method for manufacturing a surface acoustic wave device according to claim 16, wherein slow cooling from a melting
25 temperature to room temperature is performed with the load

released.

18. A method for manufacturing a surface acoustic wave device according to claim 12, wherein a collective substrate including
5 a plurality of the base substrates successively arranged is prepared,

a resin for constituting a side surface covering resin is interposed among surface acoustic wave elements joined to the collective substrate,

10 a resin for constituting a top surface covering resin is formed on another principal surface of each of the surface acoustic wave elements and on the side surface covering resin,

the resin for constituting the side surface covering resin and the resin for constituting the top surface covering resin
15 are both cured, and

the side surface covering resin and the collective substrate are cut to be separated into individual base substrate sections.

20 19. The method for manufacturing a surface acoustic wave device according to claim 18, wherein a cross-section of a surface of the side surface covering resin interposed among the surface acoustic wave elements has a recessed profile between the surface acoustic wave elements adjacent thereto.

20. The method for manufacturing a surface acoustic wave device according to claim 18, wherein the top surface covering resin includes a filler having a maximum particle size of 30 μm .

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21. The method for manufacturing a surface acoustic wave device according to claim 18, wherein the top surface covering resin comprises an epoxy resin including carbon black.

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